WHERE DOES IT FLOW?

MODELING A WATERSHED

Missouri Department of Natural Resources

GRADE LEVEL:
Upper Elementary/Middle School
High School (with extensions)

SUBJECT AREA:
Environmental Science, Earth Science and Geography

DURATION:
Preparation time:
Watershed model- 20 minutes (organize materials)
Watershed mapping- 30 minutes (access web sites and print materials)

Activity time:
One 50-minute class session (Two 50-minute periods if extensions are pursued)

SETTING: Classroom

CONCEPTS/ KEY WORDS:

Watershed
Point source pollution
Nonpoint source pollution
Riparian zones
Wetlands
Groundwater
Surface water

SUMMARY

Students will build a watershed model and explore the flow of water over their model. The students will modify the watershed model to simulate the effect of wetlands and groundwater and observe the effect of pollutants within the model watershed. These observations are then translated to their local watershed.

OBJECTIVES

THE STUDENT WILL:

- ✓ Construct a model watershed
- ✓ Observe the flow of water over their model
- ✓ Modify the model to observe the effects of wetland and groundwater systems
- ✓ Simulate pollution of the watershed and observe the effects
- ✓ Explore the difference between point source and nonpoint source pollution

Extension

- ✓ Identify the schools local watershed and determine the waterways affected by this watershed

MATERIALS

For each watershed model

- Spray bottle
- Large aluminum baking pan or plastic tub (16 x 11; 2-3 inch deep)
- Large (18 inch wide) sheet of aluminum foil
- Five to six partially crumpled soda cans
- Masking tape
- Thin sponge (red or yellow for visibility)
- scissors
- Food coloring (yellow, blue, red)
- Cup of fine soil or cocoa powder

- Newspaper or paper towels
- Pushpins or thumbtacks

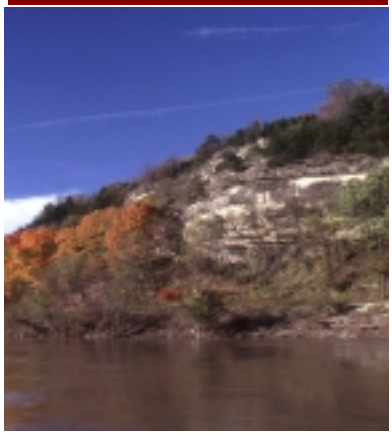
Materials for extension

- Topographic or aerial maps of your local region

Such maps are available from the Missouri Department of Natural Resources or can be obtained and printed for your area at no charge using the following website:

http://terraserver.homeadvisor.msn.com/

BACKGROUND



One of the most important natural resources in the state of Missouri is its water. While the hydrologic cycle does replenish and purify a portion of the earth's water every day; this water can take many paths prior to reaching the homeowner's faucet. The quality of our water is directly affected by the actions of upstream users.

Watersheds

A watershed is defined as an area of land that drains into a single river or body of water. This includes movement of water both as surface water and as part of groundwater systems.

A River is its watershed
-Aldo Leopold

Features such as dams, building developments, roads and other paved surfaces can often significantly alter the characteristics of a watershed. Every stream, river or body of water is the product of its watershed and results from water flowing over or through the surrounding landforms.

Groundwater

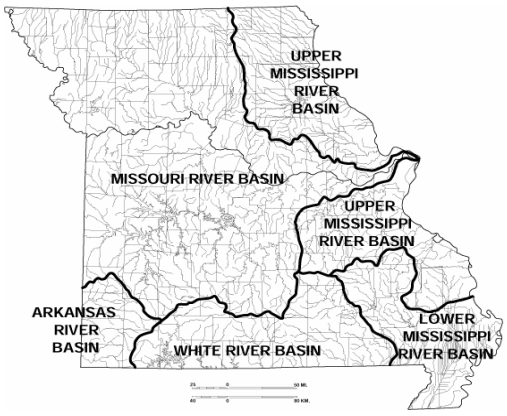
A significant portion of a watershed's precipitation is absorbed into the ground forming saturated soil, sand and rock systems called aquifers. The level of this saturated zone relative to the surface of the land is referred to as the water table. In many places the water table meets the surface contributing directly to the volume of rivers and streams by forming springs, seeps and other wetland areas. Such groundwater systems often provide a base flow of surface water during dry periods.

Wetlands

Wetlands are areas that are covered by shallow water or have waterlogged soils for all or a portion of the year. Wetlands are often formed when surface runoff saturates the soil or where ground water (the water table) meets the surface. Wetlands include areas such as bogs, marshes, swamps, fens and prairie potholes. These areas represent some of the most productive biological zones on the planet providing critical wildlife habitat. Wetlands aid in flood and erosion control by slowing down the movement of surface water. Wetlands areas also help to purify water by removing excess nutrients, suspended materials and many other pollutants.

River and Drainage Basins

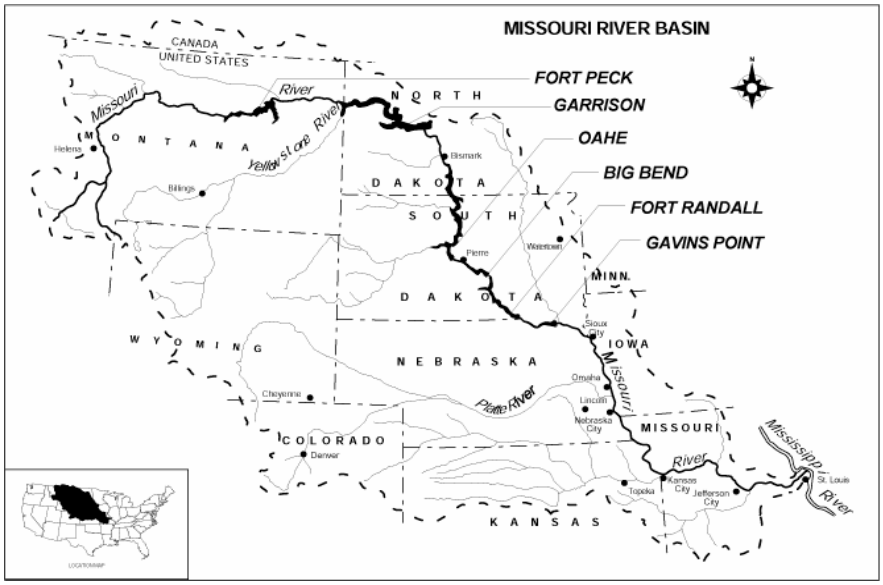
A collection of watersheds all discharging into the same major body of water is referred to as a drainage basin. A river basin is the total land area drained by a



river, including all of its tributaries.

All of the lands of the state of Missouri eventually drain directly or indirectly into the Mississippi River basin.

DID YOU KNOW?
The waters of the Missouri River provide the municipal drinking water needs for over one third of the population of the state of Missouri, representing more than 2 million people.



Detailed maps on major river basins in Missouri and specific maps of your local watershed are available on the following web sites:

SURF YOUR WATERSHED:

http://www.epa.gov/surf/

THE CENTER FOR AGRICULTURAL, RESOURCE AND ENVIRONMENTAL SYSTEMS):

http://maps.cares.missouri.edu/maproom/LocationMaps/datasources.html

Factors That Affect Water Quality

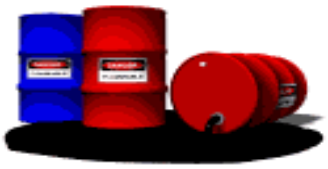
Water use by humans can be divided into two phases: How we obtain water, and what we do with the water afterwards. Following its use, water quality can be significantly altered. Substances that can end up in the water include sewage, detergents, fertilizers, pesticides, other toxic chemicals and automotive oils.

Both the surface water and the groundwater are involved in watershed function. Often these two systems are highly interconnected and pollution in one system can easily migrate and contaminate the other. Many communities obtain their drinking water from within the same watershed that receives their wastewater.

Water pollution can be divided into two categories:

Point Source Pollution

This is pollution that is characterized by an obvious entry point or source.



Examples of Point Source Pollution:

- Chemical spills
- Discharge pipe from a wastewater treatment plant
- Discharge pipe from a production factory
- Leaking underground storage tanks

Nonpoint Source Pollution

This type of pollution does not have an easily defined source and results from a wide variety of sources over a large area.

Examples of Nonpoint Source Pollution:

- Pesticide and fertilizer runoff from both farms and urban homes
- Urban storm water runoff contaminated with road salts, soil and lawn chemicals
- Paints, oil, grease and gasoline released to street storm sewers
- Overloaded septic systems
- Household chemicals carelessly dumped down drains
- Soil erosion from inappropriate land use practices associated with forestry, agriculture and livestock operations
- Solid waste, chemicals and erosion resulting from poorly managed construction sites (see picture below)

Riparian Zones

The leading cause of water quality problems in the United States is nonpoint source pollution. As a result, many communities have begun to manage the activities within their watersheds in an effort to preserve water quality.

A simple and effective way to help reduce nonpoint source pollution is to promote areas of lush vegetation along the edge of rivers and streams and wetland areas. These areas are referred to as ***riparian zones*** and are comprised of water tolerant plants such as sycamore, willow, cottonwood and sedges.

Intact riparian zones provide a buffer zone around waterways that can mitigate the effects of poor watershed practices.

- Riparian zones slow down the flow of water helping reduce erosion
- Riparian zones help to filter out sediment, chemicals and nutrients associated with surface water runoff
- Riparian zones produce organically rich soils as a result of the leaf litter generated. Such soils contain active microbial populations of bacteria and fungi that can naturally treat many of the contaminants that find their way into surface waters
- The soils of riparian zones hold water and

release this water slowly. This aids in flood control as well as helping to promote year-round surface water availability

- Riparian zones shade waterways reducing water temperatures and in turn increasing dissolved oxygen levels

- Riparian zones also offer substantial plant and animal habitat

Riparian corridors along the edge of waterways can be encouraged by using fences to keep livestock away from stream banks, by controlling development near the edge of rivers and streams, and by encouraging "green belts" as part of new construction and development plans.

The Future of Water Use

Water is truly a precious resource and how we use it or abuse it can have a direct bearing on our health. None of us can go without water.

Everything that goes on within the watershed can have an impact on water quality.

Water conservation and pollution prevention is in everyone's interest. After all, we all live downstream of other water users.

PROCEDURE

WARM UP

Set the stage by asking the students the following questions:

- *Where does the water flowing in the Missouri River come from?*

- *When it rains on the school's parking lot, where does the water go?*

- *Where does the water you drink come from?*

Suggestion: Have the students write down all the ways they can think of that they use water.

A brief list of responses can be generated on the board. These questions can be revisited at the end of the activity, allowing the students to modify or expand their initial efforts.

KEY CONCEPTS

- Watershed
- Point source pollution
- Nonpoint source pollution
- Riparian zones
- Surface water
- Wetland systems
- Groundwater systems

CONSTRUCT A WATERSHED MODEL

Note: Pictures of the watershed model are provided at the end of this activity.

- Break the class into groups of 3-4 students

- Give each group a large aluminum baking pan or tub

- Instruct the students to tape together a pile of partially crumpled soda cans in the center of the pan

- Have the students gently mold a continuous sheet of aluminum foil over the cans and the bottom areas of the pan

The goal is to create a model with several hills and sloping sides. Note: instruct the students to be careful not to tear or punch a hole in the aluminum foil as it is molded over the pile of cans.

- Give each group a spray bottle tinted with yellow food coloring (adjusted to provide a mist and not a stream of water)

- Instruct the students to gently "rain" on their watershed model and

observe where the water flows and the resulting lakes and streams that form

- The students should note how the rivers and streams stop flowing shortly after they stop "raining" on the model.

Option: Have the students draw a diagram of their watershed indicating all the lakes, rivers and streams that form. The students can indicate major population centers that might be constructed in their watershed.

Addition of Wetlands and Groundwater Systems

- Each group should cut three or four small strips of sponge and gently place these in various locations on the model.

Explain to the students that the sponge strips represent wetlands or groundwater areas that are often "recharged" by surface water. These areas then in turn contribute water to rivers, streams and lakes.

- The students should again gently "rain" on their models and observe the effects of the wetlands and groundwater systems (sponge strips) on the watershed.

The students should note that the rivers and streams found in their model will maintain flow for a longer period of time after the "rain" has stopped as a result of the addition of wetlands and groundwater systems.

Point Source Pollution

- The teacher should then place a drop of blue food coloring on a sponge near the top of the watershed model of each group.

Explain to the students that this drop of food coloring represents a ***point source*** *pollutant such as a leaking gasoline storage tank, an oil spill, or a raw sewage leak.*

- Have the groups again gently rain on their watersheds and observe what areas the pollutant impacts.

Nonpoint Source Pollution

- Next the instructor should sprinkle some fine topsoil or cocoa powder on the watershed model and have the students again create a gentle rain. The students should observe the movement of the soil or cocoa powder towards waterways and the effects on these systems.

Explain to the students that the soil or cocoa powder represents nonpoint source pollutants that can result from construction sites, agricultural practices, lawn care products and hard surface runoff.

MODIFICATIONS

- *Use strips of paper towel on portions of the watershed model to simulate riparian zones.*

  Have the students observe the difference in the movement of pollutants in areas with and without this riparian protection.

- *Create dams by pinching sections of foil and observe the effects of the reservoir that forms.*

- *Place a drop of red food coloring on an area of low elevation on the model and then a drop at a higher elevation to demonstrate which areas in a watershed have the largest impact when polluted.*

- *Give the students a pushpin or thumbtack. Ask them to pick a site where they would build a*

home on the model and mark this with the pushpin.

Have the students explain why they chose this location within the watershed.

ASSESSMENT AND INQUIRY

The following questions can be used to stimulate class discussion or the students can answer the questions individually.

1. **How did the placement of wetlands and groundwater sites (sponges) affect the flow of water on your watershed model?**

2. **Describe how pollution moved within your watershed model.**

3. **Give three examples for each of the following types of pollution.**

   POINT SOURCE POLLUTION

   NONPOINT SOURCE POLLUTION

4. **In what ways could the water users downstream of the pollution source be impacted?**

5. **What are some strategies that could be adopted to help protect watersheds?**

EXTENSIONS

MAPPING YOUR LOCAL WATERSHED

- Give the students a copy of the main river basins in Missouri or use the CARES Web site to further explore the watersheds of the state of Missouri.

- Have the students identify the river basin their community is located within.

- Have the students identify which major river their water flows toward.

- Provide the groups with a copy of a topographic map and/or arial map for your schools area.

Such maps can be obtained from the Missouri Department of Natural Resources (see order form in appendix) or can be obtained for free using the following website:

http://terraserver.homeadvisor.msn.com/default.asp

Note: Rivers and streams are indicated in blue on topographic maps and therefore do not photocopy well. The teacher may have to highlight these areas on photocopied maps. Alternatively the class can work directly with the Terrraserver web site.

- Have the students follow the flow of water from the school grounds to the nearest creek, stream, river or lake.

- Have the students discuss any sources of pollution that might end up in their local watershed such as agricultural activities, stormwater run off, factories or industries, or other sources of water pollution.

GOING FURTHER

*Have the students write an essay describing the **imaginary** path of a drop of water from the time it hits the ground to the time it reaches a river. The students should describe any pollutants the drop of water picks up along the way and how these pollutants would affect water quality.*

Potential Research Topics/Solutions to Watershed Issues: Silt fences, agroforestry, xeriscaping (water friendly landscaping), fertilizer application, grazing livestock and watersheds, agricultural irrigation methods and proper disposal of household chemicals.

WATERSHED MODEL PICTURES

CRUMPLED CAN FOUNDATION

POINT SOURCE CONTAMINATION OF WATERSHED

"RAINING" ON WATERSHED

NONPOINT SOURCE CONTAMINATION (SEDIMENT)

APPLICATION OF SPONGE "WETLANDS" AND "GROUNDWATER" SYSTEMS